



Has the Notoriously Invasive Tree of Heaven Met its Match?

Jeff Feaga, Frederick County Community Restoration Coordinator

While writing the articles presented this fall for the Monocacy and Catoctin Watershed Alliance website, I realized that I was presenting a great deal of negative information about the ongoing threat of non-native and invasive species to our natural resources. Here is some positive information about the battle against invasive vegetation.

Tree of heaven (*Ailanthus altissima*) is a well-known tree that is considered invasive in at least 40 states of the United States. *Ailanthus* was brought to the United States in the 1700's, but ultimately the tree escaped from people's gardens and began to quickly spread. One doesn't have to look far in Frederick County, Maryland to find the tree. *Ailanthus* can grow almost anywhere, but is particularly good at establishing itself in recently disturbed or graded areas, along farm fields, or even in cracks in the sidewalk. The tree has characteristics commonly associated with highly invasive species; it is fast growing, it is a prolific seeder with up to 350,000 seeds produced per tree in one season (Pannell 2002), and it can spread clonally with numerous sprouts. The growth characteristics of *Ailanthus* make it particularly hard to control. Because cutting the tree down will stimulate multiple root sprouts up to 90 feet away from the parent tree, most successful control efforts also involve the use of herbicides. Tree of Heaven has no commercial value, yet it aggressively competes for space and nutrients with native forest trees, especially after timber management or other disturbance.



The long compound leaves of tree of heaven, *Ailanthus altissima*. The tree has an unpleasant odor when crushed. Some say the odor is a cross between peanut butter and cat urine. Photo by D.

Barringer, [Natural Land Trust](#)



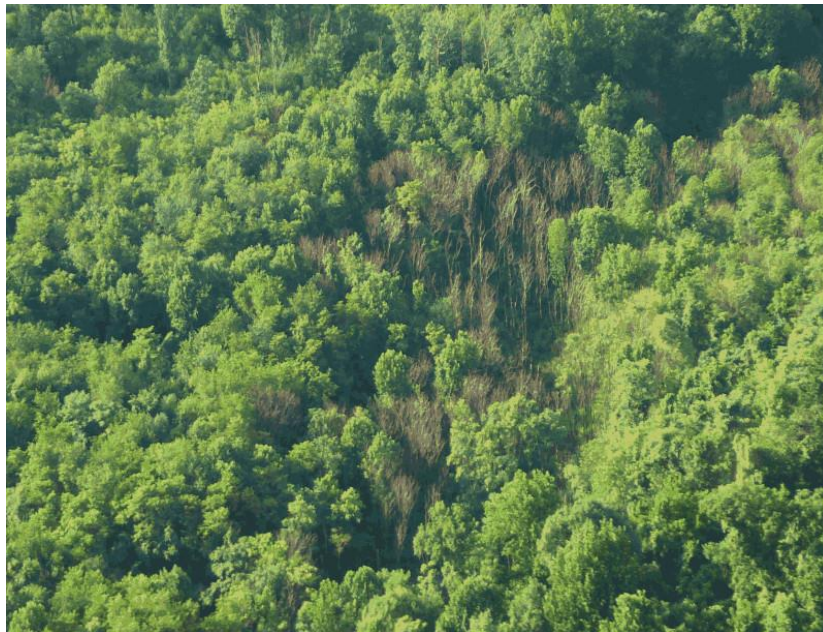
The growth habit of tree of heaven, *Ailanthus altissima*. The non-native and invasive tree can grow tall enough to be codominant or even dominant in some forests throughout the country.

Photo from [Perdue Extension](#).

That's the background of the not-so-heavenly tree of heaven. But, there is a glimmer of hope for the environments that are being challenged by this invader. Back in 2003, A Plant Pathologist at Penn State named Don Davis noticed clumps of dying *Ailanthus* in Southwestern Pennsylvania. Ambrosia beetles were observed near the dead trees. These beetles notably dig tunnels in trees and consume fungus that the beetles themselves actually spread by inoculating the tree with spores. Initial research found that the dying trees were indeed infected by a wilt-causing fungus typical of the genus *Verticillium* (Schall and Davis 2009a, 2009b). The genus *Verticillium* contains many different species, many of which cause wilting in all kinds of different plants including vegetables, flowers, and forest trees.

Subsequent research since 2003 has continued all around the country, with researchers from Penn State University, Virginia Tech, and West Virginia University leading the way. First, the wilt fungus was positively identified as a naturally occurring North American species called *Verticillium nonalfalfae*. Once the fungal species was identified, research goals focused on the prevalence of *V. nonalfalfae* in the region, the mortality rate of tree of heaven after infection of *V. nonalfalfae*, the other potential host species that can be infected and negatively affected by *V. nonalfalfae*, and maybe the greatest research question of all: can *V. nonalfalfae* be used as a natural agent to control tree of heaven?

Initial findings of these research questions are fascinating, and still leave open the possibility for *V. nonalfalfae* as an *Ailanthus* control agent. At this time, *V. nonalfalfae* has been confirmed to be present in dead tree of heaven stands not only in Pennsylvania, but also in Virginia (Snyder et al. 2013) and Ohio (Rebbeck et al. 2013). In those states where *V. nonalfalfae* was found to occur naturally, researchers were given permission to experimentally test the mortality of tree of heaven after inoculation with *V. nonalfalfae*. In Virginia, Snyder et al. (2013) found that every one of 62 tree of heaven seedlings infected with *V. nonalfalfae* developed wilt and died within 11 weeks. Using specialized hatchets that pump fungal spores into adult tree of heaven, researchers at Penn State tested inoculated *V. nonalfalfae* into 14 tree-of-heaven stands in south-central Pennsylvania. The researchers found that the treatment successfully killed the entire tree, including the sprouts. The treatments were able to completely eradicate tree-of-heaven plants, and now thousands of large dead adult tree of heaven plants can be seen in parts of Pennsylvania from natural and inoculated spread of *V. nonalfalfae*.



Aerial image of a dead tree of heaven, *Ailanthus altissima*, stand in the center of the forest. The dead stand is the result of infection with the wilt-causing fungus typical of the genus *Verticillium*. Photo from [Penn State news](#).

It seems that *V. nonalfalfae* certainly has the capacity to be a control agent, but a well-founded concern is which other tree species can be infected by *V. nonalfalfae*. Kasson et al. (2014) tested 71 woody species for their susceptibility to *V. nonalfalfae* infection and found that only devil's walkingstick and striped maple acquired infections through natural spread from infected *Ailanthus altissima*. When purposefully injected with *V. nonalfalfae*, numerous woody species showed minor wilting and the fungus was able to be reisolated from the woody tissue; however, these other species were able to survive the infection after six years. This important research shows that *V. nonalfalfae* is host adapted to tree of heaven and that other woody species are tolerant of the fungus.

Based on commonly available information, it doesn't appear that *V. nonalfalfae* has been identified in tree of heaven in any states besides PA, VA, and OH, but it seems only a matter of time before the fungus is confirmed in other states and research efforts, including inoculation, can begin. Even if (or when) the fungus becomes geographically widespread, another question is how prevalent it will be. In other words, what proportion of tree groves will be infected, and what proportion of trees within each grove will be infected? Which trees will regenerate in place of tree of heaven? These questions are being asked and

answered by researchers in live time, which I suppose is par for the course in the watch-and-see realm of invasive species ecology.

Kasson, M.T., O'Neal, E.S., & Davis, D. 2014. Expanded host range testing for *Verticillium nonalfalfae*: potential biocontrol agent against the invasive *Ailanthus altissima*. *Plant Disease*, (ja).

Pannell P.D. 2002. Tree-of-heaven control. Maryland Department of Natural Resources Forest Service Stewardship Bulletin, Hagerstown, MD.

Rebbeck J, Malone MA, Short DPG, Kasson MT, O'Neal Eric, Davis DD. 2013. First report of *Verticillium* wilt caused by *Verticillium nonalfalfae* on Tree-of-Heaven (*Ailanthus altissima*) in Ohio. *Plant Disease* 97(7): 999 <http://dx.doi.org/10.1094/PDIS-01-13-0062-PDN>

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Snyder, A.L., Kasson, M.T., Salom, S.M., Davis, D.D., Griffin, G.J., & Kok, L.T. 2013. First report of *Verticillium* wilt of *Ailanthus altissima* in Virginia caused by *Verticillium nonalfalfae*. *Plant Disease*, 97, 837–837.